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| EXAMINER | |
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| SHIKHMAN, MAX | |

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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/736,455 | METAXAS ET AL. | |
| | Examiner | Art Unit | |
| | Max Shikhman | 2609 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *15 December 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-26* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-8,10,11,14-19,23 and 24* is/are rejected.

7)☐ Claim(s) *9,12,13,20-22,25 and 26* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *21 October 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *Jan 3, 2005*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

## DETAILED ACTION

### *Claim Rejections - 35 USC § 103*

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. **Claims 1-8,10,11,14-18,23,24** are rejected under 35 U.S.C. 103(a) as being unpatentable over Hibbard (US-PAT-NO: 6249594), "Autosegmentation/autocontouring system and method" in view of Gonzalez, "Digital Image Processing, 2/E" (ISBN-10: 0201180758, Published: 11/09/2001). Hibbard discloses as follows.

() **Regarding Claim 1**:

*A method for automatically detecting breast tumors and lesions in an image comprising: acquiring an image of a breast;*

(ABSTRACT: "A system and method is disclosed for automatically computing contours representing the boundaries of objects in three-dimensional tomographic images ..."

CLAIM 1, "A method for autocontouring a two-dimensional representation of a predetermined bounded object that may be part of an image created by a predetermined modality". "Tomography" or "modality" includes breast imaging.)

*applying texture and intensity classifiers to each pixel of the image, the classifiers corresponding to probabilities of the pixel belonging to a lesion or tumor; determining a seed point in the image;*

(CLAIM 1, "(a) generating within the object an initial region of interest (ROI) with a boundary defined by a first supervised classifier based on properties of pixels inside the object compared with properties of pixels outside the object;")

*growing a region of interest around the seed point;*

(CLAIM 1, "(c) expanding the ROI boundary using the second supervised classifier...")

*calculating directional gradients for each pixel in the image;*

(Gradients have been pre-computed as lg.

Column 7, lined 8-10, "objective function is in the form M(p,lg,lr), ...lg is the gray-level gradient image,"

Column 12, line 57 shows lg.)

*determining boundary points of the region of interest using the directional gradients; and*

(CLAIM 1, "reclassifying the pixels in the current exterior layer as pixels to be included as part of the pixels within the ROI if the properties of discrete pixels in the current exterior layer substantially match in a predetermined manner the properties of the pixels within the ROI, and re-numerating the boundary of the ROI based on any reclassified pixels;")

*processing the boundary points with a deformable model to determine the presence or absence of a tumor or lesion in the image.*

(CLAIM 1, "(g) selecting a largest-valued optimal objective function that has been generated according to steps (e) and (f); and (h) creating a contour based of the objective function selected at step (g).")

Hibbard discloses everything except *filtering the image.*

Gonzalez discusses many kinds of filters; mean image filters on page 231. As Gonzalez discloses, it is desirable to implement a simple mean image filter to reduce image noise. Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention, to use Gonzalez' method in Hibbard's invention—use a mean filter to reduce image noise. Reducing image noise improves visual image quality.

() **Regarding Claim 2**:

Hibbard discloses all of the subject matter as described above except, "*digitizing the image from an analog mammogram.*"

Gonzalez discloses image sampling in Chapter 2 and in Figure 2.17. A digital mammogram is in Fig 3.4 on page 79. We need to digitize an analog Mammogram image for manipulation and storage inside computer using software executing Hibbard's method. Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention, to modify Hibbard's method with Gonzalez; first digitize a mammogram and then auto segment it using a computer. This allows for software image manipulation and storage. Software image manipulation allows for implementation of complex algorithms, like image de-noising, which improves visual image quality.

() **Regarding Claim 3**:

*The method of claim 1, wherein the step of acquiring the image comprises acquiring a digital mammogram, ultrasound, or MRI image of a breast.*

(ABSTRACT: "A system and method is disclosed for automatically computing contours representing the boundaries of objects in three-dimensional tomographic images that may be formed by computed tomography ("CT"), magnetic resonance imaging ("MRI"), positron emission tomography ("PET"), single proton emission computed tomography ("SPECT"), or other appropriate methods."

FIELD OF THE INVENTION, "The present invention relates to systems and methods for automatically inferring boundary contours of organs, tumors, prostheses, or other objects of medical interest from two-dimensional and three-dimensional images of the

physical patient anatomy from computed tomography imaging, magnetic resonance imaging, or the like.)

() **Regarding Claim 4**:

Hibbard discloses all of the subject matter as described above except, "the step of filtering the image comprises removing speckle from the image using a Butterworth filter."

Gonzalez discloses Butterworth LPF on pages 173-175, HPF on page 183, and Bandreject on page 244. Page 245, Figure 5.16, shows a Butterworth de-noised image.

It is desirable to de-noise the image for better viewing. Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention, to modify Hibbard's method with Gonzalez, and de-noise an image using a Butterworth filter. This would enhance the image for a better view.

() **Regarding Claim 5**:

*Hibbard discloses all of the subject matter as described above except, "enhancing contrast of the image."*

Gonzalez discloses *"contrast enhancement"* on Page 77 and Figure 3.2, Pages 85-86 and Figure 3.10. As shown in Figure 3.10, contrast stretching enhances the image. Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention, to modify Hibbard's method with Gonzalez's method of contrast stretching, to enhance an image.

() **Regarding Claim 6**:

*The method of claim 1, wherein the step of applying texture and intensity classifiers comprises determining intensity and local variance of each pixel of the image.*

(Column 3, lines 6-8. Column 3, lines 15-20, "Each of these qualities of edgeness and texture are associated with one or more computational methods that may be used to generate a numerical value for that property. As quantified, these properties can be used to make decisions about the segment identity of individual pixels."

Column 11, lines 35-40, "According to Expression (17) the feature vector $X=[x_1, \ldots x_n]$ has as its n-components the numeric values of several gray-level-derived measurements on the set of pixels in a neighborhood about each pixel. ... The numeric values can include the mean, standard deviation, skewness, kurtosis, energy, entropy, and the range, but also other texture measures.")

() **Regarding Claim 7**:

*The method of claim 6, further comprising applying a texture probability distribution function to the local variance of the pixel to produce the texture classifier.*

(Texture classifier is in Column 21, lines 3-14. Column 22, lines 12-20.)

() **Regarding Claim 8**:

*The method of claim 6, further comprising applying an intensity probability distribution function to the intensity of the pixel to produce the intensity classifier.*

(Column 7, lines 36-38, "The discriminant function is characterized by the assumption that the pixel gray level properties form multivariate Gaussian probability distributions.")

() **Regarding Claim 10**:

*The method of claim 1, wherein the step of growing the region of interest comprises: adding the seed point to the region of interest; and*

(CLAIM 1, "(a) generating within the object an initial region of interest (ROI) with a boundary defined by a first supervised classifier based on properties of pixels inside the object compared with properties of pixels outside the object;")

*adding pixels to the region of interest based upon connectivity and values of surrounding pixels.*

(Column 12, lines 1-10, "The third constraint is that any outside pixels that become completely surrounded by inside pixels are converted to be inside pixels. Thus, the resulting ROI perimeter will define a simply connected object.")

() **Regarding Claim 11**:

Hibbard discloses all of the subject matter as described above except, "*determining boundary points comprises scanning the region of interest horizontally and vertically to determine edge points, and combining the edge points.*"

Gonzalez discloses as follows on Page 585-587, Figure 10.16. Take horizontal gradient of the image. Take a vertical gradient of the image. Form a final image using edge linking. It is desirable to detect horizontal and vertical image edges. Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention, to modify Hibbard's method with Gonzalez. Take vertical and horizontal gradients of an

image. Link their edges. As Figure 10.16 on Page 586 shows, this highlights horizontal and vertical edges, which can be used for identification purposes.

() **Regarding Claim 14**:

*An apparatus for automatically detecting breast tumors and lesions in an image comprising: a scanner for generating an image of a breast;*

(ABSTRACT: "A system and method is disclosed for automatically computing contours representing the boundaries of objects in three-dimensional tomographic images ..." CLAIM 1, "A method for autocontouring a two-dimensional representation of a predetermined bounded object that may be part of an image created by a predetermined modality".)

*texture and intensity classifiers applied to each pixel of the image, the classifiers corresponding to probabilities of the pixel belonging to a lesion or tumor; means for determining a seed point in the image;*

(CLAIM 1, "(a) generating within the object an initial region of interest (ROI) with a boundary defined by a first supervised classifier based on properties of pixels inside the object compared with properties of pixels outside the object;")

*means for growing a region of interest around the seed point;*

(CLAIM 1, "(c) expanding the ROI boundary using the second supervised classifier...")

*means for calculating directional gradients for each pixel in the image;*

(Gradients have been pre-computed as Ig.

Column 7, lined 8-10, "objective function is in the form M(p,Ig,Ir), ...Ig is the gray-level gradient image," Column 12, line 57 shows Ig.)

*means for determining boundary points of the region of interest using the directional gradients; and*

(CLAIM 1, "reclassifying the pixels in the current exterior layer as pixels to be included as part of the pixels within the ROI if the properties of discrete pixels in the current exterior layer substantially match in a predetermined manner the properties of the pixels within the ROI, and re-numerating the boundary of the ROI based on any reclassified pixels;")

*a deformable model for processing the boundary points to determine the presence or absence of a tumor or lesion in the image.*

(CLAIM 1, "(g) selecting a largest-valued optimal objective function that has been generated according to steps (e) and (f); and (h) creating a contour based of the objective function selected at step (g).")

Hibbard discloses everything except *a filter for filtering the image;* Gonzalez discusses many kinds of filters; mean image filters on page 231. As Gonzalez discloses, it is desirable to implement a simple mean image filter to reduce image noise. Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention, to use Gonzalez' method in Hibbard's invention—use a mean filter to reduce image noise. Reducing image noise improves visual image quality.

() **Regarding Claim 15**:

*The apparatus of claim 14, wherein the scanner comprises an analog mammogram scanner, a digital mammogram scanner, an ultrasound scanner, or an MRI scanner.*

(ABSTRACT: "A system and method is disclosed for automatically computing contours representing the boundaries of objects in three-dimensional tomographic images that may be formed by computed tomography ("CT"), magnetic resonance imaging ("MRI").)

() **Regarding Claim 16**:

Hibbard discloses all of the subject matter as described above except, "*filter comprises a Butterworth filter for removing speckle from the image.*"

Gonzalez discloses Butterworth LPF on pages 173-175, HPF on page 183, and Bandreject on page 244. Page 245, Figure 5.16, shows a Butterworth de-noised image.

It is desirable to de-noise the image for better viewing. Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention, to modify Hibbard's method with Gonzalez and de-noise an image using a Butterworth filter, for better viewing.

() **Regarding Claim 17**:

The apparatus of claim 1, wherein the texture and intensity classifiers are generated by texture and intensity probability distribution functions applied to pixels of the image.

(Column 7, lines 36-38, "The discriminant function is characterized by the assumption that the pixel gray level properties form multivariate Gaussian probability distributions.")

() **Regarding Claim 18**:

*The apparatus of claim 1, wherein the means for determining the seed point retrieves a set of points of interest in the image.*

(CLAIM 1, "(a) generating within the object an initial region of interest (ROI) with a boundary defined by a first supervised classifier based on properties of pixels inside the object compared with properties of pixels outside the object;")

() **Regarding Claim 23**:

*The apparatus of claim 14, wherein the means for growing the region of interest adds the seed point to the region of interest and*

(CLAIM 1, "(a) generating within the object an initial region of interest (ROI) with a boundary defined by a first supervised classifier based on properties of pixels inside the object compared with properties of pixels outside the object;")

*adds pixels to the region of interest based upon connectivity and values of surrounding pixels.*

(Column 12, lines 1-10, "The third constraint is that any outside pixels that become completely surrounded by inside pixels are converted to be inside pixels. Thus, the resulting ROI perimeter will define a simply connected object.")

() **Regarding Claim 24**:

Hibbard discloses all of the subject matter as described above except, "*The apparatus of claim 14, wherein the means for determining boundary points scans the region of interest horizontally and vertically to determine edge points, and combines the edge points.*"

Gonzalez discloses as follows on Page 585-587, Figure 10.16. Take horizontal gradient of the image. Take a vertical gradient of the image. Form a final image using edge linking. It is desirable to detect horizontal and vertical image edges. Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention, to modify Hibbard's method with Gonzalez. Take vertical and horizontal gradients of an image. Link their edges. As Figure 10.16 on Page 586 shows, this highlights horizontal and vertical edges, which can be used for identification purposes.

3. **Claim 11** is rejected under 35 U.S.C. 103(a) as being unpatentable over Hibbard (US-PAT-NO: 6249594) in view of Fang (PGPUB-DOCUMENT-NUMBER: 20030156748).

Hibbard discloses all of the subject matter as described above except, "*determining boundary points comprises scanning the region of interest horizontally and vertically to determine edge points, and combining the edge points.*"

Fang discloses Figure 1, "[0034] Edge points P1 and P2 can be extracted by scanning the image horizontally at the position of row hy 104 and conducting a horizontal gradient operation. Similarly, edge points Q1 and Q2 can be extracted by vertical scanning at the position of column vx 102, and conducting a vertical gradient operation. Then by using Equations (1) through (3), the circle parameters can be obtained." As Fang says, to find the edges of the circle inside an ROI use horizontal, vertical scans and respective gradients. It is desirable to find the boundaries of circles. Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention, to modify Hibbard's method with Fang. Do horizontal scan and a gradient. Then do a vertical scan and a gradient. Equations 1 through 3 provide the coordinates of circles' edges. [0004] This allows for detection for circles, needed for computer vision in Surface Mounted Device (SMD) inspection applications.

4. **Claim 19** is rejected under 35 U.S.C. 103(a) as being unpatentable over Hibbard (US-PAT-NO: 6249594) in view of Mahoney (US-PAT-NO: 5239596).

Hibbard discloses all of the subject matter as described above except, "*the means for determining the seed point selects a first point from the set of points.*"

Mahoney discloses (Column 1, line 63), "But typical images include open curves and regions that are only partially enclosed, features which are difficult to analyze with

conventional techniques...discovery of near neighbor techniques that can define partially enclosed regions and other sets of pixels based on open curves and closed boundaries. A seed pixel in such a region can initially be labeled as being in the set of pixels. Each of the other pixels can then be labeled as being in the set if it has two near neighbors whose relative orientations differ by approximately 180.degree, with one of the near neighbors already in the set and the other either in the set or on a boundary." As Mahoney discloses, it is desirable to "define partially enclosed regions and ... open curves and closed boundaries." Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention, to modify Hibbard's method with Mahoney, start with one seed pixel in ROI. This helps to recognize open curves in images, a necessary task in pattern recognition for object detection.

***Allowable Subject Matter***

5. **Claims 9, 12,13, 20-22, 25,26** are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

6. The following is an examiner's statement of reasons for allowable subject matter.

**Claim 9** would be allowable because the prior art does not disclose, "*calculating a joint probability that the first point corresponds to a tumor; calculating mean joint probabilities that points in a circular region around the first point correspond to a tumor; and designating a point within the circular region having a maximum mean joint probability as the seed point*", along with other limitation of the claim.

**Claims 12** and **25** would be allowable because the prior art does not disclose, "*drawing radial lines from the seed point and plotting boundary points corresponding to positions of maximum intensity on the radial lines*" along with other limitations in these claims.

**Claim 20** would be allowable because the prior art does not disclose, "*the means for determining the seed point calculates a joint probability that the first point corresponds to a tumor*", along with other limitations in the claim.

***Conclusion***

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Yoshida (US-PAT-NO: 6078680) discloses, "Method, apparatus, and storage medium for detection of nodules in biological tissue using wavelet snakes to characterize features in radiographic images".

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Max Shikhman whose telephone number is (571) 270-1669. The examiner can normally be reached on Monday-Friday 7:30AM-5:00PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Shuwang Liu can be reached on (571) 272-3036. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Max Shikhman

4/23/2007

SHUWANG LIU
SUPERVISORY PATENT EXAMINER